

**DRAFT
ENVIRONMENTAL
IMPACT
STATEMENT**

I N T R O D U C T I O N

The first section of the Draft Environmental Impact Statement (DEIS), Affected Environment, describes the current state of the natural environment, the cultural environment, and the socioeconomic environment of the Boston Harbor Islands. The next section contains a summary of the management alternatives, and a summary of environmental impacts on the resources, the public, and the socioeconomic environments. The DEIS is concluded with a section on consultation, public involvement, and compliance with other related laws.

The Draft GMP and DEIS will be available for public review for 60 days. Following public review a proposed plan will be prepared by the Partnership, and the final draft GMP and final EIS will be published. Following a 30-day period, the plan will be submitted to the Governor of Massachusetts. Then a record of decision will be prepared by the National Park Service Northeast Regional Director for the Secretary of the Interior.

During review periods the National Park Service will accept written and oral comments. The Partnership will carefully review all comments and incorporate them, as appropriate, in the final plan and final impact statement. The National Park Service may make public any written comments it receives on the plan, including the names and home addresses of respondents; these comments may be inspected during regular business hours. Individual respondents may request that NPS withhold their home address from the planning record, which will be honored to the extent allowable by law. There also may be circumstances in which NPS would withhold from the planning record a respondent's identity, as allowable by law. If anyone wishes to have his or her name and/or address withheld, he or she must state this prominently at the beginning of the comment. The National Park Service does not consider anonymous comments. For all submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, the National Park Service will make the submissions available for public inspection in their entirety. A copy of the draft general management plan and a response form will be posted on the World Wide Web at nps.gov/BOHA/admin.

Comments should be submitted to:

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For further information, please contact the project manager at (617) 223-8666.

The alternative management proposals presented in the Draft GMP establish concepts for possible future directions for managing the Boston Harbor Islands national park area, consistent with National Park Service policies. Because the alternatives are general policy directives, the impact analysis in the draft environmental impact statement is also general. In keeping with the requirement of National Environmental Policy Act (NEPA) to evaluate site-specific impacts before "breaking ground," future impact analysis and public involvement will occur before physical development takes place. The general management plan will have narrowed the range of choices in subsequent development plan analysis to those that explore how and where to site facilities within a designated geographic management area. This is known as "tiering," and it allows the managers "to focus on the issues that are ripe for decision and to exclude from consideration issues already decided or not yet ripe," according to NPS policy (Director's Order 12).

Potential futures described in the alternatives have been arrived at, in large part, by consensus among many diverse agencies and institutions, which together operate as the Boston Harbor Islands Partnership. The melding of these agencies and the consensus-building process will continue and will produce priorities for implementation proposals in the future.

Basic to the alternatives is a set of geographic management areas each describing a range for future resource conditions and future visitor experiences. Infrastructure development and relative level of visitor use allowed within each geographic management area provide the starting point for predicting the impacts contained in the DEIS. Those impacts are based on the highest allowance in each management area.

The alternatives presented in the draft general management plan make clear that adoption of the plan will not result in changes to the resources so much as it will set the direction for future management decisions. Future implementation plans will cover: resource management, trail management, interpretation, visitor use management, comprehensive identity and signage, land protection, fire management, hazardous materials survey, integrated pest management, invasive plants management, vegetation restoration, collections management, archeological resources management, wetland and floodplain protection, shoreline and sea wall management, land and water transportation, commercial services, and public safety. See Appendix 10 for a complete list of future plans and studies.

A F F E C T E D E N V I R O N M E N T

This section describes the natural, cultural, and socioeconomic environments of the Boston Harbor Islands, some of which may be affected by implementing the alternatives. For a description of the alternatives, see page 50 of the draft general management plan.

NATURAL ENVIRONMENT

CLIMATE

Located at 42 degrees north latitude, the Boston Harbor Islands have a humid maritime climate characterized by a moderate annual range of temperatures and definite summer and winter seasons. The islands receive approximately 40 inches of precipitation annually, relatively evenly distributed throughout the year. Typically over the course of a year, there are 100 clear days, 106 days of partly cloudy weather, and 159 days of cloudy weather, with no distinct seasonal patterns. Fog occurs, on average, about two days every month.

The climate of the islands offers a particular attraction when hot, humid weather dominates the region. The modulating effect of surrounding waters typically produces significantly cooler temperatures in contrast with the city and its suburbs. Inversely, winter temperatures on the islands are warmer than those of mainland sites.

The frost-free period on the islands generally lasts from mid-May to November. Snow falls regularly between January and April, but warm air coming off the ocean causes it to melt soon after most storms. Summer air temperatures average in the 60s or above, with highs reaching into the 90s, only occasionally clearing the 100 mark. In winter, temperatures in the 20s are common, and lows can reach near zero. Harbor water temperatures range from an average of 39 degrees Fahrenheit in the winter to 68 degrees Fahrenheit in the summer.

Prevailing winds in the harbor generally move from the northwest in winter and the southwest in summer. Mean wind speed is between 11 to 12 miles per hour during the summer months, and between 14 to 15 miles per hour during winter months. The hurricane season typically begins early in September and extends into October. “Northeasters,” severe coastal storms unique to this area of North America, evolve from marine cyclones that build up southeast of New England. The winds circulate counterclockwise

and pull wind and water out of the northeast, bringing high waves and heavy rain or snow. These and other storms cause erosion to many islands. This is both part of an acceptable natural process and a maintenance/management concern (loss of island area, damage to erosion control structures, safety concerns, loss of historic structures and archeological resources).

AIR RESOURCES

The purpose of the Clean Air Act (42 USC 7401 et seq.) is to protect and enhance the nation’s air quality. States are responsible for the attainment and maintenance of national ambient air quality standards (NAAQS) developed by the Environmental Protection Agency (EPA). These standards have been established for several pollutants: inhalable particulate matter (PM-10), sulfur dioxide, nitrogen oxides, ozone, carbon monoxide, and lead. Elevated concentration of these pollutants can have adverse impacts on island resources and visitors.

Three air quality categories are established for national park system areas: class I, class II, and class III. The Boston Harbor Islands are in a class II area. The state may permit a moderate amount of new air pollution (sulfur dioxide, particulate matter, and nitrogen oxides) as long as neither national ambient air quality standards nor the maximum allowable increases (increments) over established baseline concentrations are exceeded.

The islands are part of the Boston Metropolitan Air Quality Region within which there are several large stationary and mobile sources of contaminants, including Mystic and Salem Generating Stations. Air quality in this region is also affected by air pollution transported into the region. The Boston Metropolitan Air Quality Region does not meet EPA standards for ozone or carbon monoxide. The major pollutants originating from the park are boat emissions (primary hydrocarbons, carbon monoxide, nitrogen oxides) and particulates, most of which are generated during the summer months.

A variety of particulates (salt from seawater, diatoms and other plankton, silt and clay particles from erosion and wave action) are produced as part of natural processes in the marine environment. Minor additional amounts of particulates are produced by human activities on the islands.

No monitoring of air quality or visibility is

conducted at the park, and there is no assessment of air quality–related impacts on island resources. The state Department of Environmental Protection monitors air quality in the region. The National Park Service does monitor ozone and acid deposition at Cape Cod National Seashore 60 miles to the southeast of Boston.

In 1993, the National Park Service developed a strategy to initiate actions that preserve and protect air resources in park units east of the Mississippi. Known as CLEAR (A Clearer Look at Eastern Air Resources), this program emphasizes cooperative efforts between the National Park Service, the public, and federal, state, and local agencies to minimize air pollution’s impacts on natural and cultural resources, to protect the health of park visitors and employees, and to enhance visitor enjoyment, while taking a leadership role in reducing or eliminating sources within the park.

GEOLOGY AND COASTAL PROCESSES

Boston Harbor is part of the Boston Basin, a geological feature created by a shift in the Earth’s crust millions of years before the glaciers. In the past 100,000 years, two separate periods of glaciation formed the hills that became the islands of Boston Basin and created the local drainage system, consisting of the Charles, Mystic, and Neponset watersheds. The cores of many harbor islands are drumlins—glacier-formed, asymmetrical, elongate masses of till formed into smooth-sloped hills on the Boston Basin lowlands. In profile, they look like upside-down teaspoons. As the climate warmed and the glacier receded from the Boston area some 15,000 years ago, the melting of glacial ice raised the level of the ocean, eventually creating this section of the basin and isolating the islands. Although most of the islands have one or more drumlins, many of the Brewsters and several Hingham Harbor islands are bedrock outcroppings.

Drumlins may occur as scattered single hills, or in so-called swarms. The Boston Harbor Islands are a geological rarity, part of the only drumlin swarm in the United States that intersects a coastline. This “drowned” cluster of about 30 of more than 200 drumlins in the Boston Basin are not all elongate in shape, as most other drumlins are. While nearly all drumlins were molded in the direction of glacial flow (their steeper slopes facing the glacier’s point of origin), the general northwest-to-southeast orientation of these drowned drumlins varies widely, diverging as much as 70 degrees from each other. By definition

drumlins are formed by the direction of glacial flow, and the direction of flow can vary within one glacier as the ice pushes over and around obstacles. It is likely that some of the drumlins were reworked to some degree during the time of glacial retreat when outflow from glacial rivers was high. Geologists believe the islands illustrate two separate periods of glacial action. Most of the harbor islands are composed of two layers of glacial till, their bases laid down by glacial expansion during the early Pleistocene Era, when sea level was 20 meters lower than it is now, and their upper parts deposited when the ice retreated many thousands of years later, some 16,000 years ago. The lower till of some of the island drumlins has preserved delicate fossils that are not found in the upper layers. About a dozen of the islands are not drumlins, but outcrops of bedrock generally composed of Cambridge and Braintree Argillite. Their shape and size were molded by glacial erosion; moving glacial ice removed preglacial soils and ground down surface material to expose the bedrock, which was polished by ice flow.

Natural coastal processes, especially northeast storms, continue to reshape the island landforms. Rates of erosion on the islands can be dramatic. In general, the highest rates of beach erosion occur along beaches facing north and east, which are the dominant directions for winds and seas in these storms. The shifting shores of Thompson Island illustrate this process of erosion and sedimentation. Human use of the islands also affects shoreline processes. Removal of or damaging of vegetative cover can promote erosion, whereas structures can be built to prevent erosion. General NPS policy is to let the shoreline processes take place unimpeded:

Natural shoreline processes...that are not influenced by human actions will be allowed to continue without abatement except where control measures are required by law. In instances where human activities or structures have altered the nature or rate of shoreline processes, the National Park Service will, in consultation with appropriate state and federal agencies, investigate alternatives for mitigating the effects of such activities or structures. The National Park Service will comply with provisions of state coastal zone management plans prepared under the Coastal Zone Management Act (16 USC 1451 et seq.) when such provisions are more environmentally restrictive than National Park Service management zoning. (NPS Management Policies, 1988)

There are many erosion control structures within the Boston Harbor Islands. These structures can significantly affect the rate of erosion and the movement and transport of sediments in the harbor and on the islands. Careful study and consultation will be required in the future to appropriately reconcile NPS policy with the need to protect shoreline assets. In 1978, Massachusetts adopted policies concerning the protection, development, and revitalization of coastal resources within the state. All lands on the islands, except federal lands, are subject to Massachusetts coastal zone management policies; all federal activities related to marine resources must be consistent with these policies.

In general, the geographic history of the islands can be summarized as, first, glacial shaping of landforms with a new northwest–southeast orientation; second, sea level rise after glacial retreat, which partly immersed the glacial hills to form islands, with erosion and deposition reorienting the islands to a northeast–to–southwest bearing; and third, human intervention, leading to greater local erosion control needs.

WATER RESOURCES

Boston Harbor

Boston Harbor is located in Massachusetts Bay, itself part of the Gulf of Maine. Massachusetts and Cape Cod bays stretch between Cape Ann in the north and Plymouth in the south and eastward to a boundary marked by Stellwagen Bank National Marine Sanctuary. Together they encompass approximately 1,400 square miles; Massachusetts Bay itself embraces 800 square miles.

East of the Boston Harbor Islands, Stellwagen Bank is a glacially deposited, submerged sand bank that forms critical feeding and breeding grounds for endangered marine species. The National Marine Sanctuary was designated by Congress in 1992 to protect and conserve the fragile ecosystem that the bank supports. It protects the feeding areas of migrating cetaceans (including Atlantic white-sided dolphins, harbor porpoises, and orca, pilot, and minke whales) and the nursery and feeding grounds of humpback, fin, and Northern right whales. Stellwagen is one of only 14 such sanctuaries in the United States.

In 1990, Massachusetts Bay was named an Estuary of National Significance, one of 21 in the nation. The designation made possible the allocation of a five-year, \$5 million grant under the Clean Water Act for research, the development of a management

plan for the bay, and public education and outreach. Founded in 1988, the Massachusetts Bays Program works with 49 coastal towns and 119 inland communities in Massachusetts and New Hampshire to enhance the natural and scenic resources of the bays along this coastline, improve water access, and protect public health.

Boston Harbor is divided into the Inner and Outer harbors. The Inner Harbor lies north and west of a line drawn between Logan Airport and Castle Island. It includes the mouths of the Charles and Mystic rivers and the port of Boston. The Outer Harbor includes the three bays of Dorchester, Quincy, and Hingham. The borders of the bays are formed by the mainland shoreline and various island groupings. The two harbors combined comprise approximately 50 square miles and are bounded by 180 miles of shoreline. Within the harbor are the park's some 30 islands and peninsulas, totaling approximately 1,600 acres. To illustrate the size of the harbor, the distance from Boston Common to the Outer Brewsters is the same as that from the Common to the junction of the Massachusetts Turnpike and Route 128, approximately 11 miles.

The natural watershed around Boston Harbor extends as far west as Hopkinton, Massachusetts, 25 miles inland. The farthest point from which water enters the harbor is the Quabbin Reservoir about 65 miles to the west, which supplies water to Boston and more than 100 surrounding communities.

Most of the harbor varies in depth from about 3 to 30 feet, but the north and south ship channels, between the airport and Spectacle Island and between George's Island and Hull, can reach depths of 60 feet.

Tides and Currents

Boston Harbor, with a tidal range of 9½ to 10 feet, is one of the largest tidal ranges in the United States. Tidal currents within Boston Harbor vary greatly in speed because of the irregular bottom topography and the large number of islands; the highest speeds are found at the deepest levels, and the slowest speeds are found in shallow areas. Boston Harbor has a relatively slow “flushing” rate in which about one-third of the water is “replaced” during each tide cycle. Water quality is affected by flushing rates.

WATER QUALITY

By the mid-1980s, Boston Harbor showed the effects of decades of sewage and sludge discharges,

undersized and poorly maintained treatment plants, and shoreline sewage overflows in rainstorms. Beaches were frequently closed, areas of the harbor were brown with sludge sticks, and large sections of the harbor floor were virtually devoid of life. The harbor's flounder were infamous for extraordinarily high rates of liver disease and also suffered from fin rot.

Today, Boston is approaching the completion of a \$4 billion court-ordered cleanup project by the Massachusetts Water Resources Authority, including the elimination of sludge discharge, secondary sewage treatment, and containment of combined sewer overflows. Sewage from 43 municipalities undergoes primary treatment at Deer Island, where sludge is removed (and made into fertilizer when possible) and where the remaining liquid is disinfected with chlorine and soon will be released from a nine-mile-long pipe extending east of Deer Island into Massachusetts Bay. Five thousand five hundred industries and two to three million people contribute their waste to this sewage treatment system.

Elimination of the discharge of sewage sludge to the harbor, improved sewage treatment, and pollution source controls have significantly reduced contaminant loads to the harbor. The water quality in Boston Harbor dramatically improved after 1991 when sludge was no longer dumped into the harbor. Beach closings have decreased by 50 percent since 1990, dissolved oxygen is up (the frequency and severity of anoxia has decreased), and wildlife is returning to the harbor. Overflows from combined sewers are reduced by 70 percent and still declining, and virtually all wastewater receives secondary treatment. Swimmers' advisories are down, water clarity has increased, flounder liver disease is only 30 percent, and biodiversity of the sea-floor communities has rebounded, especially in the areas formerly affected by sludge.

While the wastewater treatment facilities address most of the problem, some waste is being discharged by boaters who illegally pump-out human waste directly into the harbor and by industries that discharge treated waste into the harbor.

As is typical of many coastal areas near major metropolitan centers that have been used for waste disposal since Colonial times, Boston Harbor contains contaminants that have accumulated in the sediments of the bay. Toxic contaminants in the sewage can be divided into two major classes of metals and organic compounds. The Environmental Protection Agency has developed a list of about 100 "priority pollutants."

On average about 550 pounds of metals and 150 pounds of organic "priority pollutants" are discharged to the harbor in the 360 million gallons per day of primary-treated waste water. In declining order of abundance, zinc, copper, and lead are the most prevalent metals, while phthalates, chlorinated methanes, and ethylenes and toluene are the most common organics. A study of the sources of toxicity in Massachusetts Water Resources Authority's effluent found that most of the toxicity is caused by surfactants—the material used to increase the cleansing power of detergents.

The level of some organic contaminants, including polychlorinated biphenyls (PCBs), accumulating in the sediments within Boston Harbor has been greatly reduced because the waste stream for these substances has been slowed to a trickle. Other toxins, especially heavy metals, oil, and boat paint, continue to accumulate. Nonvolatile contaminants including PCBs, heavy metals, and some components of boat paint bind strongly to the organic muds that accumulate in the harbor so that they typically have high levels of impact primarily on benthic (bottom-dwelling) organisms and the animals that feed on them.

Disease-causing organisms, such as bacteria (indicated by fecal coliform and other pathogenic bacteria), and viruses from organic and human waste and excess nutrients, such as fertilizers, are also part of the pollution that affects Boston Harbor. Households and streets are the major sources of certain contaminants, such as toxins and fecal coliform bacteria. Industry is no longer the major contributor in terms of volume of pollutants.

In recognition of the improved water quality, the governor and the mayor of Boston appointed a Joint Commission on the Future of Boston Harbor Beaches to recommend a restoration plan for the waterfront and island beaches. The Commission's plan was funded in 1994 by \$30 million from the state legislature along with a \$500,000 challenge grant issued by the mayor. It is a five-to-seven-year plan for improvements that range from green space enhancements, bathhouse restoration, beach nourishment, and enhanced public transportation, to increased public access to the beaches.

SOILS

The soils of the Boston Harbor Islands have been classified into three major types: Hinckley-Merrimac-Urban Land; Canton-Charlton-Hollis; and Newport-Urban Land.

The Hinckley-Merrimac-Urban Land soils (found on the southwestern end of Thompson) are very deep, nearly level to steep, excessively drained soils formed in sandy and loamy glacial outwash overlying stratified sand and gravel, and areas of urban land. These soils are usually found in major stream valleys and on coastal plains.

The Canton-Charlton-Hollis soils (found on Outer and Middle Brewster, Calf, and George's) are very deep and shallow, gently sloping to steep, somewhat excessively drained and well drained, loamy soils formed in glacial till and in ice-contact, stratified drift. These soils are generally found on uplands and low hills.

The Newport-Urban Land soils (found on Long, Deer, Spectacle, Lovell's, Gallop's, Great Brewster, Grape, and Slate) are very deep, gently sloping to moderately steep, well-drained soils formed in friable, loamy glacial till overlying a firm substratum, and areas of urban land. These soils are generally found on steep hillsides in the Boston Basin.

The above soils are all excessively well drained to well drained soils (i.e., exclusively upland soils). There is also a range of wetland and intermediate soils on the islands as well as beach sands and mudflat muds.

Prime and Unique Farmlands

The U.S. Department of Agriculture defines prime farmland as the land that is best suited for food, feed, forage, fiber, and oilseed crops; unique farmland produces specialty crops such as fruit, vegetables, and nuts. According to an August 11, 1980, memorandum from the Council on Environmental Quality, federal agencies must assess the effects of their actions on soils classified by the Soil Conservation Service as prime or unique. Five soils classified as prime or unique farmland types occur within Boston Harbor Islands: Canton fine sandy loam, Merrimac fine sandy loam, Newport silt loam, Pittstown silt loam, and Sudbury fine sandy loam.

There are no historically farmed areas still in active agricultural use. Of the islands within the park, Thompson has the greatest percentage and variety of prime agricultural soils. About three-quarters of the island is composed of a patchwork of all five prime agricultural soil types. About two-thirds of Long Island and about half of Grape Island are covered with both Newport silt loam and Pittstown silt loam. Small portions of Gallop's, Lovell's, and Great Brewster are covered with Newport silt loam.

As of September 1989 (Natural Resources Conservation Service's soil survey date) about one-

third of Deer Island was composed of Pittstown silt loam, and about one-third of Spectacle Island was composed of Newport silt loam. The construction of the sewage treatment plant on Deer Island and the deposit of fill on Spectacle Island have since dramatically altered the soil content on those islands.

Groundwater

All islands with soil provide a receptacle for some groundwater. Because there is a shallow, relatively low-volume water table in the highly permeable soils on all of the drumlins, the groundwater is vulnerable to contamination from failed septic systems, chemical spills, leaching dumpsites, fuel spills, and saltwater intrusion.

UPLAND VEGETATION

The flora of the islands reflects a long history of human alteration. The islands' drumlins are thought to have been covered with mature forests of hemlock, maple, oak, pine, and hickory, which were cleared to support agriculture and pasturage, and to supply firewood for fuel. In addition, the construction of the islands' massive fortifications severely disrupted much of the native flora. A very limited number of trees were replanted when the islands' resorts and institutions were developed. One hundred thousand pines were planted during the Great Depression, but many were removed during World War II to clear the areas around fortifications. Today, patches of undisturbed native flora are rare on the islands; much of the flora is believed to be non-native. World's End and Thompson Island have expansive grasslands.

Little has been documented about the characteristics of the terrestrial environment. The upland vegetation on some islands is dominated by grasses and sumac. Succession beyond grasses and sumac usually does not occur because of active management or the recurrence of fires before this community can be replaced. In areas protected from fire, succession proceeds toward a community of mixed oak forest. Successional species including aspen, pine, birch, and white poplar are found on most of the islands. Thompson Island has the only community of mixed oak forest, covering approximately one-tenth of the island.

Found among the predominantly exotic plants that characterize the islands' vegetation is a substantial number of species (such as oriental bittersweet and multiflora rose) that are considered to be noxious and invasive, posing a threat to the future protection and restoration of native plant communities. NPS policy

prescribes that control of exotic species is to be accomplished through an integrated pest management (IPM) program. This approach involves developing an understanding of the pest's life cycle; evaluating all available methods of control; choosing an effective method, placing priority on the least toxic and potentially damaging treatment; and finally, evaluating its effectiveness.

Most of the fertile sites found on the islands were converted into agriculture over the past 300 years. The remnants of these attempts at subsistence farming are evident in the appearance of apples, pears, grapes, chives, garlic, asparagus, and horseradish.

TERRESTRIAL WILDLIFE

Birds

The diversity of upland and marine habitats provides good nesting and feeding opportunities for a number of bird species. Field surveys have identified more than 100 bird species including gulls, terns, herons, ducks, geese, hawks, plovers, sandpipers, doves, owls, woodpeckers, and perching birds. Perhaps the most commonly observed species are the great black-backed and herring gulls which breed and nest in great numbers throughout the harbor islands. Other significant bird species include: double-crested cormorant, Canada goose, snowy egret, great egret, great blue heron, black-crowned night heron, least tern, red-winged blackbird, and mourning dove.

Some birds on the islands are neotropical migrant species that move to North America in late spring and summer from Central and South America to breed and then return in fall. Populations of many neotropical migrants are declining due to loss of breeding and wintering habitat, and loss of feeding and resting places along migration routes. During migration, large numbers of shorebirds utilize the mudflats and salt marshes around the harbor, while transient hawks and songbirds regularly make use of the more remote islands, or those with suitable habitat. In late fall and winter, great flocks of waterfowl gather in harbor waters.

Mammals

A few species of terrestrial mammals occur throughout the islands, including cottontail rabbits, raccoons, skunks, gray squirrels, mice, muskrats, voles, and Norway rats. Some of these are exotic species and may become subjects of an integrated pest management plan. Non-native cats and Norway rats can impose devastating negative impacts on small vertebrates and nesting birds.

Amphibians and Reptiles

A number of species of amphibians and reptiles reportedly occur on the islands, especially the larger ones with freshwater habitats. While no formal surveys have been conducted, Eastern garter snake, Northern brown snake, and Eastern smooth green snake are known to occur.

WETLAND AND AQUATIC MARINE VEGETATION

Seagrass beds are critical wetlands components of shallow coastal ecosystems. Sheltered bays and inlets in temperate ocean waters provide a suitable environment for eelgrass (*Zostera marina*). This productive grass flourishes close to the low-tide level. The grass holds sediment, providing food and cover for a great variety of commercially and recreationally important fauna and their prey. The leaf canopy of the seagrass bed calms the water, filters suspended matter, and, together with extensive roots and rhizomes, stabilizes sediment. The once-plentiful eelgrass is the only type of seagrass now present in Boston Harbor; it is now confined to only four isolated areas. The largest is near the south coast of Bumpkin Island, and several smaller patches occur off World's End.

WETLAND AND AQUATIC MARINE WILDLIFE

The Boston Harbor Islands provide shelter and food-rich habitats for marine birds, mammals, fishes and invertebrates, as well as nurseries for their young. Much of the Gulf of Maine fauna can be found in Boston Harbor, especially around the Brewsters.

Invertebrates

Lobsters, crabs, and clams inhabit the submerged portions of the islands. Mussels and barnacles cling to the intertidal zone. Jellyfish live in the surrounding waters. Some specific species include manta shrimp, blue mussels, bean clams, lion's mane jellies, black soft-shell clams, moon jellies, hermit crabs, bay scallops, blue crabs, oysters, quahogs, razor clams, surf clams, sea stars, channeled whelk, and green crabs.

Fish

Several species of fish live in surrounding waters. They include striped bass, bluefish, and winter flounder.

Mammals

Seals haul out on some of the outer islands. Because their feeding grounds or migratory routes are nearby, humpback, fin, minke, and North Atlantic right whales and white-sided and striped dolphins are

potential, though rare, visitors, as are gray and harbor seals as strays or strandings, and harbor porpoises.

PROTECTED SPECIES

The Endangered Species Act requires that all federal agencies ensure that any actions they conduct, authorize, or fund will not likely jeopardize the continued existence of a listed species or result in the adverse modification of critical habitat. Species proposed for listing as threatened or endangered are referred to and ranked as candidate species and are also taken into consideration. Consultation with the U.S. Fish and Wildlife Service reveals that no federally listed or proposed threatened or endangered plant or animal species under the jurisdiction of the U.S. Fish and Wildlife Services are known to occur on the Boston Harbor Islands. The harbor porpoise has been proposed for listing by the National Marine Fisheries Service. Most migratory birds are protected under the Migratory Bird Treaty Act, and marine mammals by the Marine Mammal Protection Act.

Plant and animal species that could be extirpated are listed by the Massachusetts Natural Heritage and Endangered Species Program as endangered, threatened, or of special concern. Each classification reflects the species' population size and stability, its global distribution, and the threats to habitat viability (the definitions are the same for plants and animals). The Natural Heritage Program lists six species known to exist within the park, including two species listed as threatened, and four of special concern. In 1994, the state also identified coastal heron rookeries on two islands as areas of special concern. The rare species are:

- barn owl – special concern, found on Deer, Thompson, George's, and Lovell's islands
- common tern – special concern, found on Long Island
- least tern – special concern, found on Lovell's and Rainsford islands
- Northern harrier – threatened, found on Grape Island
- sea-beach dock – threatened, found on Thompson, Bumpkin, Grape, and Peddock's islands
- American sea-blite – special concern, found on Langlee Island

OTHER HABITATS OR COMMUNITIES

Ponds

Perennial ponds are found on Thompson Island and World's End.

Freshwater Marshes

Marshes are wetlands characterized by standing water some or most of the year and are vegetated with herbaceous plants, such as cattails, grasses, or sedges. The water table may be above the surface of the ground during the spring but typically recedes to below the surface of the ground during the growing season. The soil is generally soft muck and is rich with decaying organic matter. Freshwater marshes are very productive in terms of plant growth and create a large amount of organic matter. A considerable amount of material can accumulate if it is not broken down or transported away by water flow. Over time, marshes tend to fill with organic matter and become drier communities. Freshwater marshes are found on Long, Peddock's, Middle Brewster, and World's End.

Tidal Flats

Tidal flats, both sand and mudflats, are nearly level intertidal areas adjacent to coastal waters that are protected from heavy wave turbulence and typically exposed at low tide. Sand flats, which are often associated with barrier spits, are generally less protected from wave action than mudflats and are subject to constant sand movement. In the more protected areas of a sand flat, algal mats develop. Benthic fauna colonize the area and stabilize the bottom sediments. As organic matter accumulates and mixes with the sand, mudflats are formed. Eventually salt marsh plants become established, and the area that was once bare sand can become covered with salt marsh vegetation. On the islands, major sand flats occur. Mudflats, which generally occur on the periphery and at the expanding edges of salt marshes, are found on Raccoon, Snake, and Thompson islands.

Algal mats and mudflats are critical habitat for many invertebrates. Because of this they are also important feeding areas for a variety of fish and crabs. They are also critical feeding areas for migratory shorebirds.

Salt Marshes

Salt marshes are highly productive ecosystems, dominated by saltwater cordgrass (*Spartina alterniflora*), that provide habitats for many marine organisms, including many commercially valuable species of finfish and shellfish. Salt marsh systems produce a great deal of organic matter, most of which

is flushed out by the tides into shallow marine waters. Two characteristic features of a salt marsh are meandering tidal creeks and pond holes (pannes) that often remain flooded at low tide. Salt marsh sediments are characterized by dark, very fine particles rich in organic matter (peat). The largest remaining salt marshes on the islands are found on Thompson (50 acres) and on Snake (5 acres, and smaller brackish marshes have been identified on Calf, Grape, Lovell's, and Peddock's.

Rockweed/Barnacle Communities

Rockweed/barnacle communities are characteristic of rocky outcrops, dikes, and jetties within range of tides. The tidal range, wave action, light intensity, and the surface slope create three major zones of communities. The three major zones are named for the predominant organisms: the periwinkle zone with blue-green algae and lichens, the barnacle zone, and the seaweed or rockweed zone. Little Brewster, Nix's Mate, Shag Rocks, and other islands characterized by bedrock outcroppings support these rocky intertidal communities.

Beaches

Beaches are gently sloping areas adjacent to coastal waters. They are usually exposed to wave action. The sediment is typically coarser material such as sand, gravel, or cobbles. Every island within the park, except for those that are composed largely of bedrock outcrops, has beach areas lining portions of its shores. The beaches generally most attractive to recreational users in the park are found on Spectacle (recently replenished and not yet open), Long, Lovell's, and Gallop's, and are primarily of a sandy nature, possessing comparatively few biological resources. Rocky beaches, such as Peddock's, however, provide excellent habitat for invertebrates and the animals that feed on them.

Barrier Beaches

Barrier beaches are low-lying beaches and coastal dunes separating open water or wetland systems from the ocean; they comprise a complex assemblage of different landforms, environments, habitats, land cover, and land use. Numerous federal, state, and local laws have been enacted that pertain to the use and protection of barrier beaches, including the 1982 Coastal Barrier Resources Act, as amended in 1990, and the 1972 Coastal Zone Management Act, as amended in 1990. To enhance barrier beach management, the Massachusetts Office of Coastal

Zone Management has identified and delineated barrier beaches within each coastal town. Small barrier beaches have been identified on portions of Great Brewster, Gallop's, Peddock's, Bumpkin, Long, Rainsford, and Thompson islands.

Dunes

Dunes are mounds or hills of sandy material adjacent to beaches. Constant wind and wave action can serve to push the sand landward, forming the mounds. A dune may be vegetated by dune grass, or it may have no vegetation. Two islands within the park, Lovell's and Long, have dunes. Lovell's has the more extensive dune system, whereas Long's dunes are in one discrete area on its southern shore.

CULTURAL ENVIRONMENT **BUILDINGS AND STRUCTURES**

Many of the Boston Harbor Islands contain buildings and structures related to such uses as coastal defense, agriculture, commercial fishing, year-round and summer habitation, resort life, industry, public health, immigration, and social welfare. More than 100 buildings and structures, including sea walls, forts, lighthouses, gun emplacements, concrete bunkers, wood-framed cottages, and brick military and institutional buildings, reflect the long history and changing character of the Boston Harbor Islands. With several notable exceptions, the buildings and structures of the Boston Harbor Islands have not been evaluated for their historical significance but will be the subject of several studies following this general management plan.

Long Island, containing an active campus, houses health and human service programs for the city of Boston and associated tenants in roughly 20 brick buildings; it recalls the island's institutional past. Thompson Island contains administration and programs for the Thompson Island Outward Bound Education Center in 10 brick buildings and activity-related structures. Other clusters of buildings include some 40 cottages and Fort Andrews military buildings on Peddock's Island.

The partially restored Fort Warren, an impressive granite Third System fortification designated as a National Historic Landmark, has stood on George's Island as a major defensive post for the protection of the harbor in every conflict from the Civil War through World War II. Fort Andrews, erected on Peddock's Island in the first decade of the 20th century, is a rare example of a relatively intact coastal

fort of the Endicott Period (1888–1905); its 26 remaining buildings and structures, many with red brick walls and slate roofs in a simple Colonial Revival style, have suffered over 50 years of abandonment and are generally in poor condition. Military use of the islands continued into the Cold War with a Nike missile site on Long Island. Artillery batteries, constructed during successive reinforcement campaigns throughout the nation’s history, remain in varying states of obscurity and disrepair on many of the islands as evidence of a continuously evolving, integrated system of coastal defense.

Navigational aids constructed to guide ships through the often treacherous harbor waters include Boston Light on Little Brewster Island, a National Historic Landmark purported to include portions of the oldest lighthouse structure in the United States; and two lights on the National Register of Historic Places, Graves Light on The Graves and Long Island Head Light on Long Island. Other navigational aids include the channel marker on Nix’s Mate and the Deer Island light off the tip of Deer Island. No longer operating are Lovell’s Island range lights and Spectacle Island range lights (held in storage).

Cottages on Peddock’s Island, dating from the early 20th century, are the last remaining residential structures on the harbor islands (aside from the year-round institutional residences on Thompson and Little Brewster). They are occupied by their owners during the summer and allude to the former prevalence of summer communities and recreational activities in the harbor, as well as fishing communities. In recent years, the Metropolitan District Commission has been acquiring, evaluating, and removing the cottages as owners vacate them.

On Deer Island a 1889 pump station, renovated for use as a visitor center, contains a community room and exhibits of historic pumps, recalling early attempts to deal concertedly and scientifically with the region’s waste water that has been discharged to Boston Harbor since 1878. Contemporary structures include 12 egg-shaped sewage “digesters” each standing 170 feet high on the southern end of the island. Part of the sewerage system is a nine-mile pipeline that will carry treated effluent beyond the harbor and into Massachusetts Bay. On Moon Island, four huge granite containers of a “state-of-the-art” sewage treatment plant built in 1873 remain, as does an outmoded and discontinued sewage treatment plant constructed about 1900 on Nut Island.

CULTURAL LANDSCAPES

The Boston Harbor Islands contain numerous cultural landscapes that, when combined with historic structures, archeological resources, and associated museum collections, relate the history and culture of the people that shaped the cultural resources in the vicinity of Boston Harbor. Most cultural landscapes of the harbor islands are characterized as “historic vernacular,” those imprinted by the settlement, customs, and everyday use of people who altered the physical, biological and cultural character of their surroundings. Fields and forests once inhabited by American Indians were later used as Euro-American farms and pastures, that, when abandoned, transformed through natural succession into stands of trees, shrubs, vines, and herbaceous vegetation. On Middle Brewster and Calf islands the stone walls, house foundations, and remnants of gardens still demarcate the summer communities that thrived prior to World War I. On Grape Island a farmhouse foundation and a lone willow tree remain, while horse pastures abandoned during World War II have reverted to tree cover.

Many islands may also be defined as “ethnographic landscapes,” those containing natural and cultural resources that associated people define as “heritage resources” such as contemporary settlements, subsistence communities and burial grounds. Such places can be found on Peddock’s, Deer, Long, the Brewsters, and many other islands. On Peddock’s Island, a community of summer cottages, previously a fishing village, has been in active use for nearly 100 years. On Deer Island, the tragic internment of “Christian Indians” during King Philip’s War marks a chapter in the region’s history and is a place of great importance to contemporary Indians.

A surprising number of harbor islands and associated peninsulas are “historic designed landscapes,” those consciously laid out by a landscape gardener, architect, or horticulturist according to design principles or by others in a recognized style or tradition. At World’s End the stymied residential development proposal conceived by landowner John Brewer in the 1880s has allowed Frederick Law Olmsted, Sr.’s design of tree-lined roads to endure with remarkable clarity and integrity, creating a unique and appealing designed landscape setting. Vestiges of military landscape design, including grading for defensive structures, and plantings that are notably uniform in species and design, can be found on

numerous islands including George's, Gallop's, Peddock's, and Long islands. On George's Island the many acres of sculpted earthen walls, batteries, parade ground, demilune, sea walls, tunnels, as well as stately shade trees, are an integral part of the defensive design of the impressive 19th century Fort Warren.

Institutional use of the harbor islands has contributed landscape spaces that reflect their nurturing and optimistic philosophies, including Gallop's, Long, Deer, Bumpkin, and Spectacle. On Gallop's Island, hedges, flowering shrubs, fruit and shade trees line walkways and surround foundations of buildings long since removed. The plants are reminders of an island that was once home for several thousand immigrants, quarantined on the island between 1867 and 1937, and for several hundred young servicemen who trained at the radio school during World War II. On Long Island, a grotto, cemeteries, an orchard, an old greenhouse, and a new greenhouse reflect the island's 100 year history of caring for those in need.

Many islands are also recognized as "historic sites," those places associated with a historic activity, event, or person. Sites such as the lighthouses on Little Brewster, The Graves, and Long Island contain landscape features that contribute to their significance. The utilitarian and barren landscape of Little Brewster, bounded by rocky bluffs, portrays the lifestyle of keepers who have tended the light for nearly 300 years.

ARCHEOLOGICAL SITES

The Boston Harbor Islands have a rich human history, some of which is revealed by physical evidence including prehistoric and historic archeological resources. The islands contain evidence of American Indian use of such archeological significance that, to date, 21 islands have been designated within an archeological district listed on the National Register of Historic Places. Archeologists assume that all islands not surveyed have potential prehistoric or pre-contact sites. In particular, the park's enabling legislation directs that park managers include programs to protect Indian burial grounds and sites associated with the King Philip's War.

Soils, which contain highly alkaline shell fragments, have helped preserve bone as well as remains of tools and foods that typically deteriorate in New England soils. This, coupled with the fact that most of the islands were never long or intensively inhabited by Euro-Americans, suggests that they are likely to provide the best remaining or most easily retrievable evidence of prehistoric human occupation

in the Boston Bay area. Similar mainland sites are less likely to have survived undisturbed. Archeologists have established that the islands were used or inhabited by humans at least 8,000 years ago, and a 4,100-year-old human skeleton unearthed on one island in the late 1960s is one of the oldest ever excavated in New England. Most known shell middens, essentially dumps for food and other waste, are on the south-facing sides of islands closest to shore, corroborating local historical speculation about the popularity of the islands for shellfishing among American Indians. Sites of other middens may since have been covered by the rising sea level.

The Moswetuset tribe, after which the colony and the Commonwealth were named, surely used the harbor islands. (Moswetuset Hummock, the residence of Sachem Chickatawbut, was nearby, in the Squantum section of Quincy, and is listed on the National Register of Historic Places.) The Moswetuset's descendants, as well as other contemporary tribes with cultural affiliation to the region, tell stories of life prior to arrival of Europeans. Archeological remains and historical documents show that American Indian use involved shellfishing and agriculture. When John Smith explored the harbor in 1614, he noted that "here are many Isles all planted with corn."

Archeological sites of the historic period have not been systematically surveyed, although many are known to exist on the islands. Fifteen types of sites are known: agricultural, cemetery, fishing colony, fortification, hospital, hotel or resort, industrial, poorhouse, prison, prisoner-of-war camp, quarantine, sewage treatment, lighthouses, dumps, and miscellaneous other site types. Many of the sites are potentially eligible for listing on the National Register of Historic Places, such as David Thompson's trading post. The sites of the Long Island poorhouse (1882) and almshouse (1891), and the Rainsford Island poorhouse (1866) and almshouse (1852), are potentially significant because of Boston's important role in the American social reform movements.

ETHNOGRAPHIC SITES

Traditionally associated groups—American Indians, and perhaps Irish, Portuguese, military families, fishermen, farmers, lighthouse keepers, and others—have ties to the Boston Harbor Islands, but research remains to be done to determine the extent of ethnographic sites on the Boston Harbor Islands. Deer Island, to single out one island of ethnographic importance, has been used historically by American

Indians, quarantined immigrants, farmers, orphans, “paupers,” military personnel, and tens of thousands of prisoners (at the recently demolished county house of corrections), but it has special significance to American Indians as a place of internment in King Philip’s War. During the winter of 1675–76, American Indians from at least four “praying villages”—people who had become Christianized and were friendly with the English settlers—were forcibly removed to Deer Island. Estimates of people held on the islands vary, but research indicates that at least half of the American Indians on the islands died of exposure or lack of food, water, or appropriate medicines. Those that were finally released in May 1676 dispersed because their existing communities had become devastated. Native Americans return to Deer Island every year in October to solemnly commemorate their ancestors’ suffering in this sorrowful historical chapter.

In the 1840s, when the potato famine drove a million or more Irish citizens to emigrate to the United States, Deer Island was a landing point for thousands, many sick and poverty-stricken, where the city of Boston established a quarantine hospital in 1847. Approximately 4,800 people were treated in the first two years, but more than 800 died and were buried in the Rest Haven Cemetery. In 1850, an almshouse was built to house paupers. Later institutional uses on Deer Island were a reform school, a county house of corrections, and a sewage treatment plant.

COLLECTIONS AND ARCHIVES

A substantial museum collection related to the Boston Harbor Islands, comprising more than 6,000 items, is scattered among more than a dozen organizations, ranging from local, city, state, and federal agencies and repositories, to private and nonprofit groups and institutions. The collection includes archeological, archival, historical, and natural history objects in a variety of print and nonprint formats. Annual reports, resource-specific monographs and anthologies, local guidebooks, natural resource inventories, interpretive materials, pamphlets and articles, other archival materials (including manuscripts, scrapbooks, clippings, and correspondence), planning documents, and technical reports are among the print matter that documents the history and continued uses of the islands’ natural and cultural resources. A broad range of historical and contemporary maps, plans, illustrations, photographs, and ephemera contribute to the overall collection as both a reference source and an

interpretive tool. A cultural landscape study on the islands will soon be published containing an annotated bibliography of relevant source material, providing standard bibliographic data as well as thematic, descriptive, and locational notations. A natural resource bibliography for the islands is under way.

SOCIOECONOMIC ENVIRONMENT

POPULATION AND EMPLOYMENT

Population in the Boston Metropolitan Area Planning Council (MAPC) region, consisting of 21 cities and 80 towns extending over 1,422 square miles, was 2,922,934 according to the 1990 census. This figure is expected to increase to 3,074,480 by the year 2020, representing an increase of 5.2 percent. Substantial increases in population of over-35 age groups are forecast for this period, with a corresponding decrease in children and young adults. By 2010 the number of people between the ages of 35 and 64 should account for 44 percent of the total population. Household numbers are also expected to increase 13.7 percent by the year 2020, a rate markedly higher than population growth due to an expected decline in household size.

Employment in the MAPC region is projected to increase by 14.6 percent by the year 2020. The principal limiting factor in future employment growth is considered to be a limited supply of labor rather than demand. In 1996 the unemployment rate for the region was 4.3 percent. Continuing low rates are forecast for the future.

THE ECONOMY

The Boston metropolitan area is the economic hub of both the Commonwealth of Massachusetts and New England, providing governmental, professional, business, financial, higher educational, and medical services as well as important transportation, communications, export, cultural, and entertainment activities. Metropolitan Boston is the seventh largest Consolidated Metropolitan Statistical Area (CMSA) in the nation.

After exceeding many measures of economic growth nationwide during the period of 1982 through 1988, the Boston metropolitan area experienced an economic decline coinciding with a regional recession in 1989 and 1990. In 1991 and 1992 the entire region continued to display weaknesses in job growth, employment rates, income, housing, and the commercial real estate market.

Economic data for the period of 1993 through

1997 indicates that the region has emerged from this recession and in most sectors has achieved a complete recovery, showing a 10.1 percent increase in total employment.

Mirroring the CMSA, Boston has shown the most dramatic economic improvements in the services, retail trade, and the finance, insurance, and real estate (FIRE) industries.

The service sector has been the city's fastest-growing industry during the past 25 years. In 1970, services accounted for just over 25 percent of the total job market. Today, service employment constitutes over 45 percent of the city's jobs.

This sector is large and varied, encompassing, among others, lawyers, health-care workers, teachers, architects, and hotel workers. The hotel industry currently employs more than 11,600 people and the cultural and entertainment sector employs nearly 10,200 people.

While wholesale trade has failed to keep up with the rest of the city's posted job gains, retail trade continues to do well, with current employment levels at near parity with pre-recession figures. This market is fueled by a large resident student and tourist population and the presence of a downtown with exceptional vitality. The city has also shown notable success in neighborhood retail trade. Boston is the first city in the country to institute the Main Streets Program—an effort managed by the National Trust for Historic Preservation to revitalize historic neighborhood retail centers. Eighty-five new businesses and more than 500 jobs have been created in 15 Main Street Districts in the city.

A significant aspect of this sector is represented by Boston's 1,700 restaurants, which generate over \$60 million in annual meals tax revenue (17 percent of the Commonwealth's total) and employ nearly 30,000 people. Visitors are estimated to spend a total of \$6.4 billion annually in metropolitan Boston establishments.

Incremental increases in Boston's economic growth have been predicted to continue in the near term in the range of one to two percent per year. This growth is expected to be driven principally by expansion in the services and FIRE sectors, but continued growth is also expected in the retail sector in both regional and neighborhood centers.

According to the Greater Boston Convention and Visitors Bureau, tourism is Massachusetts' second-ranked industry. In 1993 an estimated 2.8 million

tourists visited Boston, combining with business and other travelers to spend \$3.8 billion in Suffolk County and contributing nearly \$120 million to city and state tax revenues. It is estimated that tourism accounts for 6 to 7 percent of total local jobs. Despite the apparent significance of these figures, the travel and tourism industry is considered to offer great potential as a growth area in the region. This idea appears to be supported by the facts that the hotel and motel markets are under-served in Boston compared with national totals, that Boston hotels show high occupancy rates.